Industrial Applicability

According to the present invention, since a highly precise phosphor layer can be simply formed on the highly precise spaces between barrier ribs , a widely applicable high quality plasma display with a phosphor layer usable as a highly precise plasma display can be obtained. In addition, the plasma display can be produced continuously at a high productivity level industrially advantageously.

The highly precise plasma display obtained in the present invention can be used widely in the display field for wall mounted television sets and information displays.

Claims

1. A method for producing a plasma display, comprising the step of continuously applying a phosphor paste containing a phosphor powder and an organic compound onto a substrate with a plurality of barrier ribs , from a paste applicator with a plurality of outlet holes, to form a phosphor layer.

2. A method for producing a plasma display, comprising the steps of coating a substrate with a plurality of barrier ribs , with three phosphor pastes respectively containing a phosphor powder emitting light of red, green or blue, as stripes in the spaces between the respectively adjacent barrier ribs , from a paste applicator with outlet holes, and heating to form a phosphor layer.

3. A method for producing a plasma display, according to claim 1 or 2, wherein the space (S) between the respectively adjacent barrier ribs and the average diameter (D) of the outlet holes satisfy the following formula:

$$10\ \mu m \leqq D \leqq S \leqq 500\ \mu m$$

4. A method for producing a plasma display, according to claim 1 or 2, wherein the outlet holes are formed in a flat plate or as nozzles or needles.

5. A method for producing a plasma display, according to claim 1 or 2, wherein the paste applicator used has 20 to 2000 outlet holes.

6. A method for producing a plasma display, according to claim 5, wherein the paste applicator used has 150 to 2000 outlet holes.

7. A method for producing a plasma display, according to claim 1 or 2, wherein the paste applicator used has 16n ± 5 (n is a natural number) outlet holes.

8. A method for producing a plasma display, according to claim 1 or 2, wherein the paste applicator ~~used~~ has the outlet holes at a pitch of 0.12 to 3 mm.

9. A method for producing a plasma display, according to claim 1 or 2, wherein the paste applicator ~~used~~ has the outlet holes at a pitch corresponding to 3m times (m is an integer of 1 to 10) the pitch of the barrier ribs.

10. A method for producing a plasma display, according to claim 1 or 2, wherein the paste applicator ~~used~~ satisfies the following formula:

$$L/D = 0.1 \sim 600$$

where L is the length of the outlet holes, and D is the average diameter of the outlet holes.

11. A method for producing a plasma display, according to claim 1 or 2, wherein the paste applicator used for coating is 60 to 400 μm in the average diameter (D) of outlet holes.

12. A method for producing a plasma display, according to claim 1 or 2, wherein the phosphor pastes are applied while the distance between the top ends of the barrier ribs formed on a glass substrate and the tips of the outlet holes of the paste applicator is kept at 0.01 to 2 mm.

13. A method for producing a plasma display, according to claim 1 or 2, wherein pastes respectively containing a phosphor material different in the color of the light emitted ~~from it~~ are discharged from one paste applicator, and the shortest distance between the outlet holes applying phosphor pastes mutually different in color is 600 μm or more.

14. A method for producing a plasma display, according to claim 1 or 2, wherein two or more independent paste applicators are simultaneously used for coating.

15. A method for producing a plasma display, according to

claim 14, wherein the two or more paste applicators are driven to travel at the same speed.

16. A method for producing a plasma display, according to claim 2, wherein coating is effected ~~one~~ color by ~~one~~ color, and the coating of each color is followed by drying.

17. A method for producing a plasma display, according to claim 1 or 2, wherein the paste applicator and the glass substrate are moved ~~relatively~~ relative to each other in parallel to the barrier ribs on the glass substrate.

18. A method for producing a plasma display, according to claim 1 or 2, wherein to stop the application of the phosphor pastes, the paste applicator is kept at a negative pressure internally.

19. A method for producing a plasma display, according to claim 1 or 2, wherein after the paste applicator and the substrate have been started to be moved relatively each other in parallel to the barrier ribs on the substrate, the application of phosphor pastes is started, and before the relative movement is stopped, the application is stopped.

20. A method for producing a plasma display, according to claim 1 or 2, wherein each of the phosphor powders used is 0.5 to 10 μm in the grain size of 50 wt% of the powder and 0.1 to 2 m^2/g in specific surface ~~area~~.

21. A method for producing a plasma display, according to

claim 1 or 2, wherein each of the phosphor ~~powders~~ pastes used consists of 30 to 60 wt% of a phosphor powder, 5 to 20 wt% of a binder resin and a solvent, wherein the ratio by weight of the phosphor powder to the binder resin is 6 : 1 ~ 3 : 1.

22. A method for producing a plasma display, according to claim 21, wherein the binder resin is a cellulose compound.

23. A method for producing a plasma display, according to claim 21, wherein the solvent contains terpineol.

24. A method for producing a plasma display in which three phosphor pastes respectively containing a phosphor powder emitting light of red, green or blue are applied to the spaces between respectively adjacent barrier ribs on a glass substrate, to form a phosphor plane, according to claim 2, wherein the phosphor existing in the portions other than the predetermined coating positions are removed by letting them adhere to an adhesive material.

25. A method for producing a plasma display, according to claim 1 or 2, wherein the phosphor deposited at ~~the~~ top ends of the barrier ribs are removed by letting them adhere to an ~~adhesive material~~.

26. A method for producing a plasma display, according to claim 1 or 2, wherein each of the phosphor pastes used satisfies the following relation:

$(2H + P - W) \times 5 \leqq H \times (P - W) \times a/100 \leqq (2H + P - W) \times 30$

where H is the height of each barrier ribs (μm); P is the pitch of the barrier ribs (μm); W is the width of each barrier rib (μm); and a is the phosphor powder content of the phosphor paste (vol%).

27. A method for producing a plasma display, according to claim 1 or 2, wherein the phosphor pastes used have a viscosity of 2 to 50 Pa·s.

28. A method for producing a plasma display, according to claim 1 or 2, wherein the phosphor pastes are photosensitive phosphor pastes.

29. A method for producing a plasma display, according to claim 28, wherein each of the photosensitive phosphor pastes ~~used has~~ have the following composition:

Organic component	:	15 ~ 60 parts by weight
Phosphor powder	:	40 ~ 85 parts by weight
Solvent	:	10 ~ 50 parts by weight

30. A method for producing a plasma display, according to claim 1 or 2, wherein the barrier ribs are provided as stripes with the following dimensions:

Pitch	:	100 ~ 250 μm
Width	:	15 ~ 40 μm
Height	:	60 ~ 170 μm

31. A method for producing a plasma display, according to claim 1 or 2, wherein the barrier ribs are black on ~~the top~~ their top

surfaces.

32. A method for producing a plasma display, according to claim 1 or 2, wherein the lateral side wall thickness (T1) of the phosphor layer at the position corresponding to a half of the height of each barrier rib and the bottom wall thickness (T2) of the phosphor layer satisfy the following relation:

$10 \leqq T1 \leqq 50$ μm

$10 \leqq T2 \leqq 50$ μm

$0.2 \leqq T1/T2 \leqq 5$

33. An apparatus for producing a plasma display, comprising a table for fixing a substrate with a plurality of barrier ribs formed on the surface, a paste applicator with a plurality of outlet holes to face the barrier ribs of the substrate, a supply means for supplying a phosphor paste to the paste applicator, and a moving means for three-dimensionally moving the table and the paste applicator relatively each other.

34. An apparatus for producing a plasma display, according to claim 33, wherein the relation between the average diameter (D) of the outlet holes of the paste applicator and the space (S) between the respectively adjacent barrier ribs satisfies the following formula:

10 μm $\leqq D \leqq S \leqq 500$ μm

35. An apparatus for producing a plasma display, according to claim 33, wherein the outlet holes of the paste applicator are

not circularly formed, and the length (B) of each of the holes almost perpendicular to the barrier ribs and the space (S) between the respectively adjacent barrier ribs satisfy the following relation:

$$10\ \mu m \leqq B \leqq S \leqq 500\ \mu m$$

36. An apparatus for producing a plasma display, according to claim 33, wherein the pitch of the outlet holes of the paste applicator is 3m times (m is an integer of 1 to 10) the pitch of the barrier ribs.

37. An apparatus for producing a plasma display, according to claim 33, wherein the outlet holes of the paste applicator are on the same plane.

38. An apparatus for producing a plasma display, according to claim 33, wherein the outlet holes of the paste applicator are formed by pipes with the same form.

39. An apparatus for producing a plasma display, according to claim 33, wherein the number of outlet holes of the paste applicator is ~~20~~ 150 to 2000.

40. An apparatus for producing a plasma display, according to claim 33, wherein the number of outlet holes of the paste applicator is 16n ± 5 (n is a natural number).

41. An apparatus for producing a plasma display, according to claim 33, wherein the pitch of the outlet holes of the paste applicator is 0.12 to 3 mm.

42. An apparatus for producing a plasma display, according to claim 33, wherein the average diameter (D) of the outlet holes of the paste applicator and the length (L) of each of the outlet holes satisfy the following relation:

$$L/D = 0.1 \sim 600$$

43. An apparatus for producing a plasma display, according to claim 33, wherein the average diameter of the outlet holes of the paste applicator is 60 to 400 μm.

44. An apparatus for producing a plasma display, according to claim 33, wherein the centers of the outlet holes of the paste applicator are located above the spaces between the respectively adjacent barrier ribs.

45. An apparatus for producing a plasma display, according to claim 33, wherein the faces and/or inner walls of the outlet holes of the paste applicator are coated with a fluorine based resin film.

46. An apparatus for producing a plasma display, according to claim 33, wherein the faces and/or inner walls of the outlet holes of the paste applicator are coated with an amorphous carbon film.

47. An apparatus for producing a plasma display, according to claim 33, wherein the paste applicator has a plurality of phosphor paste storage sections, phosphor paste supply ports for supplying phosphor pastes to the storage sections, and

passages for fluid communication between the storage sections and the outlet holes; the number of outlet holes is larger than the number of storage sections; and the outlet holes corresponding to the respective storage sections are arranged cyclically according to a predetermined order almost on a straight line.

48. An apparatus for producing a plasma display, according to claim 33, wherein two or more paste applicators are arranged.

49. An apparatus for producing a plasma display, according to claim 33, wherein a plurality of paste applicators are provided for respectively different phosphor pastes, and a plurality of phosphor paste supply devices are provided to supply the phosphor pastes for the respective paste applicators, so that ~~the~~ spaces between the barrier ribs of the substrate may be simultaneously coated with the plurality of phosphor pastes.

50. An apparatus for producing a plasma display, according to claim 33, wherein a pressure adjusting means capable of setting the pressure in the paste applicator as desired in a range from atmospheric pressure to a negative pressure, and a control means to control the timing of the pressure adjustment are provided.

51. An apparatus for producing a plasma display, according to claim 33, wherein a detecting means for detecting the

positions of the outlet holes of the paste applicator, a detecting means for detecting the positions of the barrier ribs or the spaces between the barrier ribs of the substrate, a detecting means for detecting the position of the top ends of the barrier ribs on the substrate, a detecting means for detecting the position of the tips of the outlet holes of the paste applicator and a control means for controlling the start and end of applying of the phosphor paste in response to the relative position between the outlet holes of the paste applicator and the substrate are provided.

52. An apparatus for producing a plasma display, according to claim 33, wherein an adjusting means for adjusting the inclination degree of the paste applicator to the top ends of the barrier ribs of the substrate, and a control means for keeping the tips of the outlet holes of the paste applicator at a predetermined distance from and in almost parallel to the top ends of the barrier ribs of the substrate are provided.

53. An apparatus for producing a plasma display, according to claim 33, wherein a detecting means for detecting the position in the substrate, of the phosphor paste applied from the paste applicator onto the substrate is provided.

54. An apparatus for producing a plasma display, according to claim 33, wherein a detecting means for detecting the number of the barrier ribs or the spaces between the barrier ribs on

the substrate, and a recognizing means for recognizing the spaces between the barrier ribs to be coated, from the detected number of the barrier ribs or the spaces between the barrier ribs are provided.

55. An apparatus for producing a plasma display, according to claim 33, wherein a reference mark detecting means for detecting a reference mark on the substrate, and a moving means and control means for relatively moving the paste applicator and the barrier ribs so that the outlet holes of the paste applicator may be located above the spaces between the barrier ribs to be coated with the phosphor paste are provided.

56. An apparatus for producing a plasma display, according to claim 33, wherein a means for cleaning the outlet hole faces of the paste applicator is provided.

57. An apparatus for producing a plasma display, according to claim 33, wherein a means for removing the phosphor paste existing in other portions than the predetermined coating positions of the substrate is provided.

58. An apparatus for producing a plasma display, comprising three coating devices provided in series to respond to three phosphor pastes, which are respectively equipped with a table for fixing a substrate with barrier ribs , a paste applicator with a plurality of outlet holes to face the barrier ribs of

the substrate, a supply means for supplying phosphor pastes to the paste applicator, and a moving means for three-dimensionally moving the table and the paste applicator relative to ~~relatively~~ each other.

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